

WE CLAIM:

1. A humidification system adapted to deliver humidified gases at a desired level of humidity, flow and temperature to a patient comprising:

- 5 (a) gases supply means providing a flow of gases,
(b) humidification means having an electrical input power and capable of humidifying said gases up to a level of humidity prior to delivery to said patient,
(c) flow measuring means that determines the flow of said gases before entry of said gases to said humidification means,
10 (d) humidity sensing means measuring the humidity of said gases before entry of said gases to said humidification means,
(e) first temperature sensing means measuring the temperature of the air external to said humidification system,
(f) transportation pathway means, having a heating means, said pathway means
15 conveying said humidified gases from said humidification means to said patient, and
(g) control means including stored instructions to:
i) determine a transportation pathway heating means input power based on at least said temperature of said air as measured by said first temperature sensing means and said flow of said gases as measured by said flow measuring means,
20 ii) determine a humidification means input power based on at least said flow of said gases as measured by said flow measuring means and said humidity of said gases as measured by said humidity sensing means to achieve said desired humidity, flow and temperature of said gases, which are to be supplied to said patient.

2. A humidification system according to claim 1 wherein said humidification means
25 comprises a humidification chamber adapted to receive a volume of water and water heating means to heat said water, said gases passing through said humidification chamber, through a gases inlet and out a gases outlet, and evaporating said water, said gases thereby being humidified.

3. A humidification system according to claim 1 or 2 wherein said humidification system
30 further includes a second temperature sensing means measuring the temperature of said water heating means.

4. A humidification system adapted to deliver humidified gases at a desired level of humidity, flow and temperature to a patient comprising:

- (a) gases supply means providing a flow of gases,
 - (b) humidification means having an electrical input power and capable of humidifying said gases up to a level of humidity prior to delivery to said patient,
 - (c) flow measuring means measuring the flow of said gases before entry of said
5 gases to said humidification means,
 - (d) humidity sensing means measuring the humidity of said gases before entry of said gases to said humidification means,
 - (e) first temperature sensing means measuring the temperature of the air external to said humidification system,
 - 10 (f) second temperature sensing means measuring the temperature of said water heating means,
 - (g) transportation pathway means, having a heating means, said pathway means conveying said humidified gases from said humidification means to said patient, and
 - (h) control means including stored instructions to:
 - 15 i) determine a transportation pathway heating means input power based on at least said temperature of said air as measured by said first temperature sensing means and said flow of said gases as measured by said flow measuring means,
 - ii) determine a required temperature of said water heating means based on at least said flow of said gases as measured by said flow measuring means and said humidity
20 of said gases as measured by said humidity sensing means,
 - iii) determine the actual temperature of said water heating means from said second temperature sensing means,
 - iv) vary input power of said water heating means to cause said actual temperature to approach said required temperature to achieve said desired humidity, flow and
25 temperature of said gases supplied to said patient.
5. A humidification system according to claim 4 wherein said humidification system further includes a third temperature sensing means measuring the temperature of the gases before entry of said gases to said humidification means.
6. A humidification system according to claim 4 or 5 wherein said control means further
30 includes instructions to determine said humidification means input power based on said flow of said gases as measured by said flow measuring means, said humidity of said gases as measured by said humidity sensing means, and said temperature of said gases as measured by said third temperature sensing means.

7. A humidification system according to any one of claims 4 to 6 wherein said humidification system includes pressure sensing means measuring the pressure of said gases before entry of said gases to said humidification means.
8. A humidification system according to any one of claims 4 to 7 wherein said control means further includes instructions to determine said humidification means input power based on said flow of said gases as measured by said flow measuring means, said humidity of said gases as measured by said humidity sensing means, said temperature of said gases as measured by said third temperature sensing means and said pressure of said gases as measured by said pressure sensing means.
9. A humidification system according to any one of claims 4 to 8 wherein said humidification system includes an additional gases input port and at least one oxygen sensing means located in said flow of gases to measure said gases oxygen concentration.
10. A humidification system according to claim 9 wherein said additional gases input port allows for the addition of oxygen to said flow of gases through said humidification system.
11. A humidification system according to any of claims 9 or 10 wherein said control means further includes instructions to determine said humidification means input power based on said flow of said gases as measured by said flow measuring means, said humidity of said gases as measured by said humidity sensing means, said temperature of said gases as measured by said third temperature sensing means and said oxygen concentration of said gases as measured by said oxygen sensing means.
12. A humidification system according to any one of claims 1 or 7 to 11 wherein said gases supply means, said humidification means, said flow measuring means, said humidity sensing means, said first and second temperature sensing means, said pressure sensing means and said control means are housed in one housing so that there are no external sensors and wiring extending from or on said humidification system to hinder said patient or other user of said humidification system.
13. A humidification system according to claim 12 wherein said housing has an external inlet for gases into said gases supply means and an outlet for said humidified gases, where said outlet is from said humidification chamber which is connected to said transportation pathway means by way of a connector that provides both an electrical and pneumatic connection between said humidification chamber and said transportation pathway.

14. A humidification system according to any one of claims 4 to 13 wherein said humidification system includes transportation pathway means overheating detection for said heating means comprising:

detecting means which include means to detect a current in said heating means, and
5 detection control means which stores a program which causes the control means to:

i) receive input of said current in said heating means from said detecting means,

and

ii) if said current is below a safe current value, then reduce the power to said heating element from a operating current value to at least said safe current value, else return to

10 i),

iii) increase the power to said heating element after a predetermined time to said operating current value.

15 15. A humidification system according to claim 14 wherein said transportation pathway means is an extruded plastic tube, and said heating means is at least two conductive wires embedded within the wall of said tube to be partially or wholly contained within said wall.

16. A humidification system according to claim 15 wherein the cross sectional profile of said extruded plastic tube is such that total collapse or total occlusion is not possible during bending

20 17. A humidification system according to claim 15 or 16 wherein said extruded plastic tube includes two or more co-extruded layers of differing plastic materials with varying properties.

18. A humidification system according to any one of claims 4 to 17 wherein said heating means is a positive temperature co-efficient heating element, for example in a wire or tape form.

25 19. A humidification according to any of claims 4 to 18 wherein said humidification means includes a float valve system for controlling the level of liquid in a chamber comprising:

a valve body having an inlet for coupling to a liquid supply conduit and an outlet adapted to communicate with said chamber,

30 a first valve seat formed in said body through which liquid must pass to reach said outlet,

a second valve seat formed in said body located downstream of said first valve seat, through which liquid must pass to reach said outlet,

first and second floats adapted to be disposed within said chamber,

a first valve member actuated by said first float so as to close onto said first valve seat upon the first float assuming a position corresponding to a first predetermined level of liquid in said chamber,

5 a second valve member actuated by said second float so as to close onto said second valve seat upon the second float assuming a position corresponding to a second predetermined level of liquid in said chamber, said second predetermined level of liquid being higher than said first predetermined level of liquid,

10 a cylindrical actuating member connected to said second valve member in order to control displacement of said second valve member in response to said second float,

an inner actuating member connected to said first valve member in order to control displacement of said first valve member in response to said first float, said inner actuating member being disposed within said cylindrical actuating member,

15 said cylindrical actuating member and said inner actuating member independently connecting said first and second floats to respective valve members, and operable to allow free relative movement between said first and second valve members.

20. A humidification system according to any one of claims 4 to 19 wherein said gases supply means is a fan driven by a variable speed electric motor.

21. A humidification system adapted to deliver humidified gases at a desired level of humidity, flow and temperature to a patient comprising:

- 20 (a) gases supply means providing a flow of gases,
- (b) humidification means having an electrical input power and capable of humidifying said gases up to a level of humidity prior to delivery to said patient and an inlet receiving said gases from said gases supply means and outlet to pass said gases to said patient,
- 25 (c) flow measuring means measuring the flow of said gases before entry of said gases to said humidification means,
- (d) humidity sensing means measuring the humidity of said gases before entry of said gases to said humidification means,
- (e) first temperature sensing means measuring the temperature of the air external to said humidification system,
- 30 (f) second temperature sensing means measuring the temperature of said gases passing out said outlet,

(g) transportation pathway means, having a heating means, said pathway means conveying said humidified gases from said humidification means to said patient, and

(h) control means including stored instructions to:

5 i) determine a transportation pathway heating means input power based on at least said temperature of said air as measured by said first temperature sensing means and said flow of said gases as measured by said flow measuring means,

ii) determine a required temperature of said gases passing out said outlet based on at least said flow of said gases as measured by said flow measuring means and said humidity of said gases as measured by said humidity sensing means,

10 v) determine the actual temperature of said gases passing out said outlet from said second temperature sensing means,

vi) vary input power of said water heating means to cause said actual temperature to approach said required temperature to achieve said desired humidity, flow and temperature of said gases supplied to said patient.

15 22. A humidification system according to claim 21 herein said gases supply means, said humidification means, said flow measuring means, said humidity sensing means, said first and second temperature sensing means, and said control means are housed in one housing so that there are no external sensors and wiring extending from or on said humidification system to hinder said patient or other user of said humidification system.

20 23. A humidification system as herein described with reference to the accompanying figures.